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ABSTRACT

This study explores the interpretation of two types of flow diagrams composed of different visual elements intended to communicate the same meaning. Using linear and cyclical diagrams, the study focused on whether, given a series of diagrams using linear elements and a series using cyclical elements, both types of visuals convey the same message to viewers in relation to instructional design information. Ninety-three college students were asked to read flow diagrams, either composed of boxes connected by straight lines or ovals connected by curved lines, and immediately write three to five adjectives describing the diagram. It was discovered that: (1) the two flow diagrams were not perceived as having significant differences in the message they conveyed; (2) both types were perceived as being appropriate for the display of instructional design models, although the ovals diagram was perceived as being more representative of the synergistic nature of the instructional design process; (3) the ovals diagram was interpreted by more participants as a means of sending a more interactive interdependent message; and (4) both diagrams elicited similar adjectives from the participants, and therefore neither was perceived as giving a more accurate portrayal of the instructional design process. Two figures provide the flow diagrams. (Contains 34 references.) (MAS)

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The Role of Graphic Elements in the Accurate Portrayal of Instructional Design

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The elements of a visual display should form a coherent system and convey a message that is unambiguous. "The role of the visual is a projection of the intent or purpose of its' creator. Illustrations in text are usually there to support the text and carry the authors' message and agenda" (Braden, 1994, p. 199), simplifying the readers' information processing. This type of processing involves perception and interpretation of a diagram.

Perceptions and interpretations can be influenced by the designers' choice of visual elements, which should help show the relationships among elements. Diagrams are the connection between an idea and the formation of a message. Grabowski (1991) defines message design as planning for the manipulations of the physical form of the message. Designs depicting processes such as flow diagrams are usually sequential and involve a directional element. Lines are one of the basic design elements found in visual communication. Lines are used to make shapes, indicate direction, and form outlines. "There are three basic shapes, all formed using lines: the triangle, the square, and the circle. All other shapes or forms are made using these basic figures" (Dondis, 1973, p. 44). "When we look at an image, our eyes tend to start in the upper left corner and then move around the image as we are directed to by lines, shapes, and other phenomena" (Berger, 1989, p. 47). Learning from print involves learning to sequence information and therefore to think in linear, sequential ways. The traditional way of thinking in most cultures, which uses a linear mode, often represented by a hierarchical model, should be replaced by a relational, interdependent way of visualizing.

This presentation reports on a comparison of two types of flow diagrams with similar content. "Graphic elements are entities in a diagram that represent objects, events, and concepts in an information network" (Hardin, 1988). For example, the ◆ is typically recognized as the symbol for a decision point in the display of a logic pattern whereas an ----> denotes direction or movement. This study is about the importance of meaning associated with selected

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visually illustrate ways in which graphic elements influence perception of entire models. "A visually literate person should be able to understand (read) images and use (write) visual language" (Ausburn & Ausburn's study, as cited in Hortin, 1978) intelligently. "The higher order thinking skills of analyzing, synthesizing, and interpreting the visual image do not come naturally" (Goldstone, 1989, p. 592). Higher order skills involve using abstract thinking skills, which must be taught in order to facilitate the ability to creatively construct meaning from visual displays. "Visual Literacy can be defined as the ability to comprehend and create information that is carried and conveyed through visual imagery" (Considine & Haley, 1992, p. 14). Visual Literacy refers to a group of vision competencies a human being can develop by seeing and at the same time integrating other sensory experiences. The development of these competencies is fundamental to normal human learning, and when developed, they enable a visually literate person to discriminate and interpret the visible actions, objects, and/or symbols, natural or man-made, that he encounters in his environment. Through the creative use of these vision competencies, he is able to communicate with others. Through appreciative use of these abilities he is able to comprehend and enjoy the masterworks of visual communication (Miller, 1985). Visual Literacy is based on the assumptions that:

1. interpreting visual images is idiosyncratic,
2. reading visual messages is a learned capability, and
3. through use of visual competencies, we can design messages which enable the potential for learner achievement.

Visual messages are as much a part of the communication process as is language. Readers should be able to translate both written and visual ideas to form a complete message. Visual literacy enables better use of both written, spoken, and visual skills. Visual displays help viewers understand content and therefore understanding these images becomes important in its' own right. We must therefore explore visual messages systematically, with the same attention given to the study of linguistics.

The study of visual communication is also important in that it helps sustain research on how people learn. Fleming (1983) states that teachers of instructional design still have problems in using appropriate imagery to attain desired learning outcomes. "Students can be taught to recognize, read, recall, and comprehend visual messages" (Considine & Haley, 1992, p. 15). Once people understand the method of designing and using visual messages they can use them effectively in their own attempts at learning. The application of visual communication to Educational Technology enables instructional designers to increase their ability to share both methods and concepts with current students and incorporate these ideas into "courses throughout the curriculum" (Schamber, 1991, p. 20). "Organized

content and instruction of visual communication and its associated technology is necessary to enlighten and educate students for an information age and lifelong learning" (Bell, 1993, p. 12). The study of visual communication will benefit instructional design professionals as well as students in instructional design programs by allowing them to apply visual design techniques to aid the learning process and increase the probability of the receiver correctly interpreting the message being sent.

Procedural models, such as those that portray instructional design processes, depict a sequence of functions or tasks required to achieve some type of goal, and commonly employ visual elements. The instructional design process presented in Figure 1 employs a variety of graphic elements to communicate different types of functions toward a specified purpose. The connotations attached to each element represent a micro perspective of the entire procedure as well as contribute synergistically to the whole procedure as perceived by the viewers.

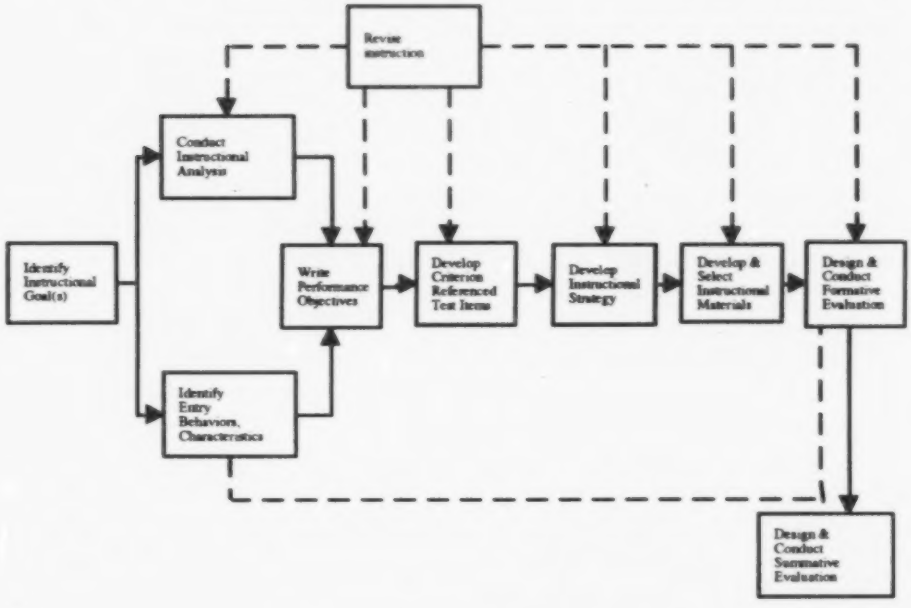

Figure 1. Dick and Carey (1990)

Graphic elements which elicit viewer interpretations that are inconsistent with the original intent of the entire procedure diminish the effectiveness of a procedural model used to portray accurate functions or tasks. To the average viewer it may be unclear that the model presented in Figure 1 was intended to portray sets of functions and tasks which represented iteration, an open systems approach, and a systematic process. The same information is displayed in Figure 2, but the graphic elements, as well as their juxtaposition, are arranged in such a way as to convey meaning that is more consistent with the original intent of the procedure.

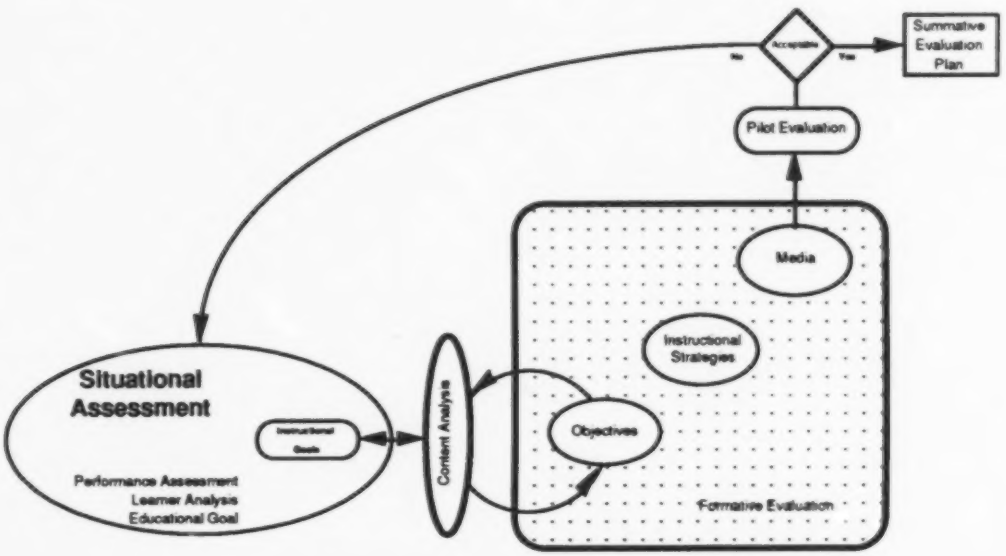

Figure 2. Branch (1994)

Perception

Perception is a relative thing, based on the relationship of visual elements to the environment, our own personal characteristics, how we organize information to make meaning, and our cultural experiences. "To perceive is to become aware through the senses, particularly through sight or hearing, and to achieve understanding by means of such awareness" (Preble, 1989, p. 5). Visualization has more to do with mental processing than physical ability. The mind and eye must work together to interpret visual images and conceptualize what we see. "Good diagrams promote understanding" (Hardin, 1994, p. 20) and clarify relationships. The importance of using effective visuals, and of knowing what makes them effective, is significant in communicating information. The majority of the communication process takes place through images. "We receive 80% or more of our information through our eyes, and much of this communication is done indirectly, through symbolic means: by words and signs and symbols of all kinds" (Berger, 1989, p. 1). The left brain is mostly involved in analytical, logical thinking, especially in verbal and mathematical processing. Its' mode of operation is primarily linear, and processes information sequentially. The right brain specializes in holistic information processing such as our orientation to space, art, body image, and recognition of faces. Both sides are involved in visual processing.

A study of intended and perceived image content showed a wide spread in the way people perceived picture contents, with very poor agreement between intended and perceived content (Pettersson, 1987). Gestalt psychology shows that perceptually the meaning of a whole diagram depends on the relationship between its' parts. "Everyday visual perception is, in fact, a continuous flow of these complex interrelationships" (Preble, 1989, p. 8). Visual elements have a conceptual relationship based on their similarity, proximity, and continuity.

Perception of the relationships in diagrams is also based on language training. Learned conventions such as reading from left to right, and top to bottom cause us to assume relationships even when none exist. Causal connections and subordinate effects are attributed to elements of the diagram based on how they are positioned. These biases are cultural and are learned by almost everyone at an early age.

Perception includes many similarities to cognitive processes, using existing schema on which to build new information. Based on this the content of a diagram becomes much more important than its' format. Visual information is usually retained longer in memory than verbal information. Using visuals also increases the level of retention of the viewer. Using both verbal and visual material causes dual encoding. This gives the reader a greater chance of recalling the information at a later date, and being able to use the information as the foundation on which to build further cognitive

information as the foundation on which to build further cognitive structures. The quality of the images used is therefore extremely important in building schema on which to base future cognitive processing.

Instructional Design

Instructional design involves the systematic planning of instruction to increase its effectiveness and help people learn. Systematic planning is based on a series of pre-determined steps generated by knowledge of how people learn. "All the stages in any instructional systems model can be categorized into one of three functions: (1) identifying the outcomes of the instruction, (2) developing the instruction, and (3) evaluating the effectiveness of the instruction (Gagne, Briggs and Wager, 1992, p. 21). The systems approach is an interactive process which uses feedback to determine if its goals have been achieved. Systems models are iterative by nature, and revision continues until the desired outcomes are reached.

The effectiveness of the systems approach to instructional design is based on learner outcomes, the linkage between systems components, and the process being both empirical and replicable. The emphasis of a true systems approach is the process. Therefore, systems theory remains the theoretical origin for the majority of existing instructional design models (Edmonds, Branch and Mukherjee, in press). Many of today's instructional design models were designed in relation to a specific context such as K-12 education, higher education, business and industry, or government training needs (Edmonds, Branch and Mukherjee, in press). The uniqueness of the situation generated a model flexible enough to accommodate the needs of that particular environment and to design effective instruction for that situation.

Instructional Design professionals typically employ models that are based on systems theory to guide their practice (Edmonds, Branch and Mukherjee, in press). A system is a regularly interacting or interdependent group of items framing a unified whole (Edmonds, Branch and Mukherjee, in press). These models are part of the communication process within the field of instructional design, and enable us to explore, understand, and describe hierarchical characteristics, relationships and interactions, parameters, dynamics patterns, results of integration and synthesis, and modifications in system patterns (Edmonds, Branch and Mukherjee, in press). Instructional Design models should communicate the idea of multiple iterations and the cyclical nature that occurs in reality.

Instructional design models should be based on the idea of input-process-output, and have specific goals, results, or products which predetermine their use. Instructional designers also use models to communicate project requirements, to aid management practices, or to help in the decision making process. "Instructional design models are divided into three categories: (1) classroom focus; (2) product focus; and (3) system focus" (Gustafson,

1991, p. 6). The classroom focus involves designing better instruction. Product focus revolves around quick and efficient development of deliverables. Systems focus is based on the design of complete courses or curricula, and involves much more analysis of the task, the context, and the intended audience.

Research Questions

This study explored the interpretation of two types of flow diagrams composed of different visual elements intended to communicate the same meaning. Using linear and cyclical diagrams the study focused on whether, given a series of diagrams using linear elements and a series of diagrams using cyclical elements, both types of visuals conveyed the same message to viewers in relation to instructional design information and practice regardless of the type of diagram they were given. The specific questions were:

1. Do flow diagrams convey meanings typically associated with the process of instructional design?,
2. Do flow diagrams composed mainly of boxes and straight lines with arrows illicit the same adjectives as flow diagrams composed mainly of ovals and curved lines with arrows?, and
3. Do flow diagrams composed mainly of ovals and curved lines with arrows accurately portray the instructional design process more than flow diagrams composed mainly of boxes and straight lines with arrows?

Methodology

The participants were 93 college students at a University in the northeastern United States. The gender distribution was 54 females, 38 males, and one unknown, the age range was 20 and older, and 45% of the participants were in the 20 to 30 year old age category. The distribution of professional occupations and college majors showed that 37% of the participants were involved in instructional design as either graduate students or designers, another 21% were teachers, and 42% were from a variety of other occupations and college majors. The participants were randomly assigned to one of the two treatment conditions.

The task for each of the participants was to read a flow diagram and immediately write three to five adjectives to describe the diagram. The first treatment condition (Boxes) required the participants to read a flow diagram composed essentially of boxes connected by straight lines with arrows. The second treatment condition (Ovals) required the participants to read a flow diagram composed essentially of ovals connected by curved lines with arrows. Figure 3 represents the actual diagram read by the participants of the Boxes group. Figure 4 represents the actual diagram read by the participants of the Ovals group. Each participant was given two minutes to write three to five adjectives in a space provided on the same page of the diagram.

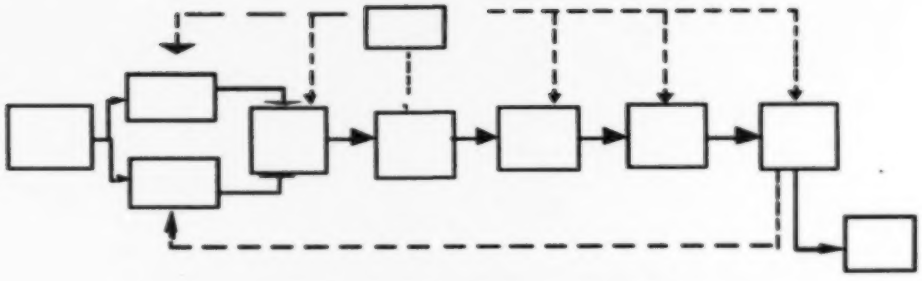

Figure 3. Flow Diagram A: Boxes with Straight Lines and Arrows

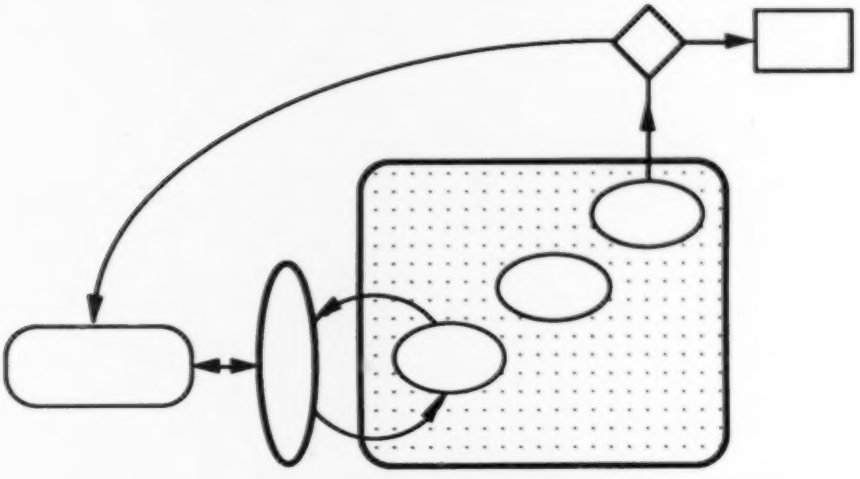

Figure 4. Flow Diagram B: Ovals with Curved Lines and Arrows

Data Analysis

The data were analyzed by tabulating all the written responses from the participants to determine frequencies, and to generate categories for describing the perceptions of the respondents relative to their perceptions about the diagrams they read. This method is consistent with that used in a study done by Branch, Moore, and Sherman (1988) which looked at the criteria for hiring instructional designers as professors or for positions in business and industry, and with a study conducted by Braden and Baca (1991) which looked at the components of visual literacy. The adjectives for each flow

diagram were combined using a collegiate thesaurus (Merriam-Webster, 1991) and a collegiate dictionary (Webster, 1991) to identify words with the same meaning.

Results

Research Question 1: *Do flow diagrams convey meanings typically associated with the process of instructional design?*

Yes, similar adjectives were used to describe both flow diagrams. Words consistently referenced in the literature to describe the instructional design process were included as adjectives for the boxes and ovals flow diagrams such as linear, flowing, systematic, directional, iterative, busy, systemic, and structured.

Research Question 2: *Do flow diagrams composed mainly of boxes and straight lines with arrows illicit the same adjectives as flow diagrams composed mainly of ovals and curved lines with arrows?*

The results were inconclusive, due to the similarity of the lists of adjectives generated by the participants. While similar words were included in both lists (see figure 5) the adjectives used to describe the flow diagram with ovals also included words such as circular, geometric, cyclical, visual, and interactive.

Ovals		Boxes	
confusing	22	systematic	27
systematic	15	linear	16
flowing	14	sequential	11
circular	14	complex	10
visual	12	flowing	9
busy	7	boxed	6
beautiful	5	structured	6
geometric	5	related	5
bizarre	4	clear	5
interactive	4	feedback	4
directional	4	iterative	4
iterative	4	systemic	4
intriguing	3	busy	3
closed	3	detailed	3
systemic	3	design	3
structured	3	directional	3
non-linear	3	angular	2
moving	3		
linear	3		
simple	2		
boring	2		

Figure 5. List of Combined Adjectives

Research Question 3: *Do flow diagrams composed mainly of ovals and curved lines with arrows accurately portray the instructional design process more than flow diagrams composed mainly of boxes and straight lines with arrows?*

Based on the frequency with which participants cited both diagrams as cyclical or flowing both flow diagram types tend to portray an iterative, concurrent procedure, however, it appeared that the diagram using ovals did so more frequently. Further, the ovals tended to represent the synergistic nature of the instructional design process more than the boxes evidenced by comparing the frequencies of the first six words on each list (Figure 5).

Conclusions

1. The two flow diagrams, composed of different types of visual elements, were not perceived as having significant differences in the message they conveyed.
2. Both types of flow diagrams were perceived as being appropriate for the display of instructional design models, although the ovals diagram was perceived as being more representative of the synergistic nature of the instructional design process.
3. The ovals diagram was interpreted by more participants as a means of sending a more interactive, interdependent message.
4. Both flow diagrams illicited similar adjectives from the participants, and therefore neither was perceived as giving a more accurate portrayal of the instructional design process.

Discussion

The results provide preliminary data about the type of visual elements used in accurately portraying the processes and procedures associated with instructional design. Use of ovals and curved arrows effected both the meaning of the diagram and the perception of the relationships among the visual elements. The ovals diagram more accurately portrayed the fluid, flexible nature of the instructional design process, where as the boxes diagram was considered more rigid and structured. This is a better picture of the way instructional design takes place in reality; it is not necessarily a lock step procedure, but a more interactive, systemic process.

Several limitations were encountered during the study: (1) students past familiarity with flow diagrams may have influenced their perceptions of the drawing they were given during the study. This is a preliminary study, and the participants all had some introduction to instructional design. In the next stage of this study we will also be using participants who have no familiarity with instructional design, to see if their responses are significantly different from those collected in this study. (2) Students ability to translate their mental perceptions into verbal language using adjectives may have been a factor in their choice of descriptors. There is some question as to whether

the term "adjective' influenced how participants thought about the flow diagrams, and what words they would have chosen if they had not been restricted to using only adjectives. This will be addressed differently in the next phase of data collection, where participants will either be asked use descriptive terms instead of adjectives, to describe the flow diagrams, or will be given a list of the most frequently cited words from this study from which to choose descriptors. Additionally, some self-imposed limitations were identified at the start of the study in order to make it manageable within the time available and workable with the population available for sampling. Also the number of participants included in the study was dependent on the time available for data collection and analysis.

The amount of learning that takes place when using visuals is dependent on what the learner knows and what skills the learner already has for reading the messages encoded in the visuals. "Another important factor is the strategy the teacher uses to guide or direct the learner's perceptual attention to the critical attributes of the visual material" (Fredette, 1994, p. 236). Better training in visual literacy will help instructional design professionals create visuals that are more easily understood, and will help students interpret those visuals more appropriately, thereby increasing learner achievement.

Recommendations

Instructional design professionals can improve the quality of the messages received by viewers by better understanding the use of visual elements in the portrayal of models, flow diagrams, and ideas. "Text and pictures should convey the same message or content so as to reduce the number of potential interpretations and increase the learning effect" (Pettersson, 1989, p. 217). Teaching visual literacy in classrooms across disciplines is necessary to help students learn more efficiently and make meaning of the variety and amount of information with which they come in contact on a daily basis. The need to convey messages to the intended audience, in this case students or other instructional design professionals, means we must better design instructional design models for optimum effect and to insure that the intended message reaches the audience.

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